Resolution and Fidelity Issues for Underwater Acoustic Environmental Modeling

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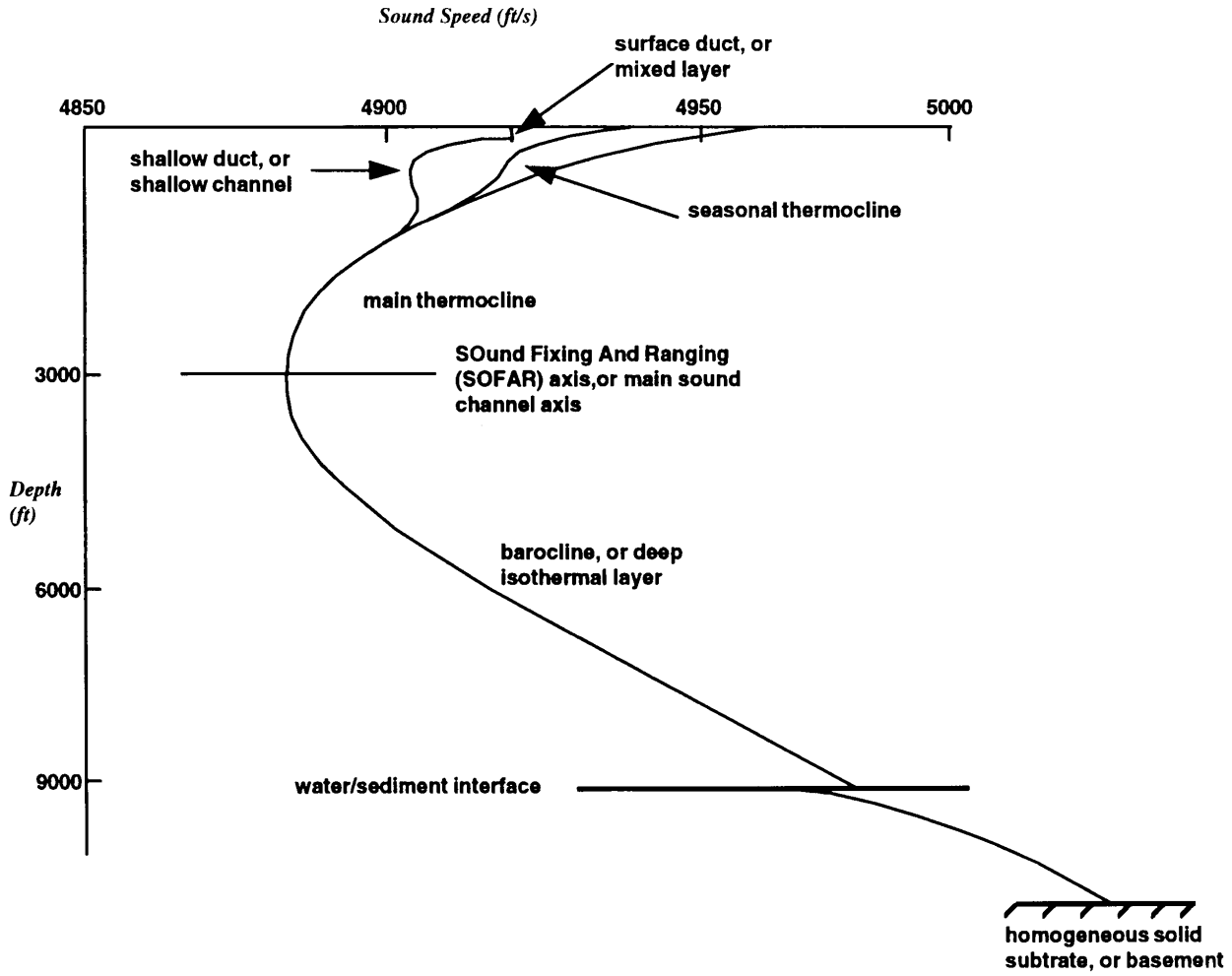
Modeling and Database Issues from the Navy's USW Perspective

- Relative Sophistication of Models and Databases Confers Gaming Advantage
- In USW Acoustics, the Models and Databases Are Tightly Coupled

Outline

- **Basics of Underwater Acoustics**
- **Examples of Gaming Advantage that Exploit:**
  - Relative Sophistication of Acoustic Propagation Models
  - Differences in Database Resolution
- **Interoperability Status**
  - GASS
  - BFTT

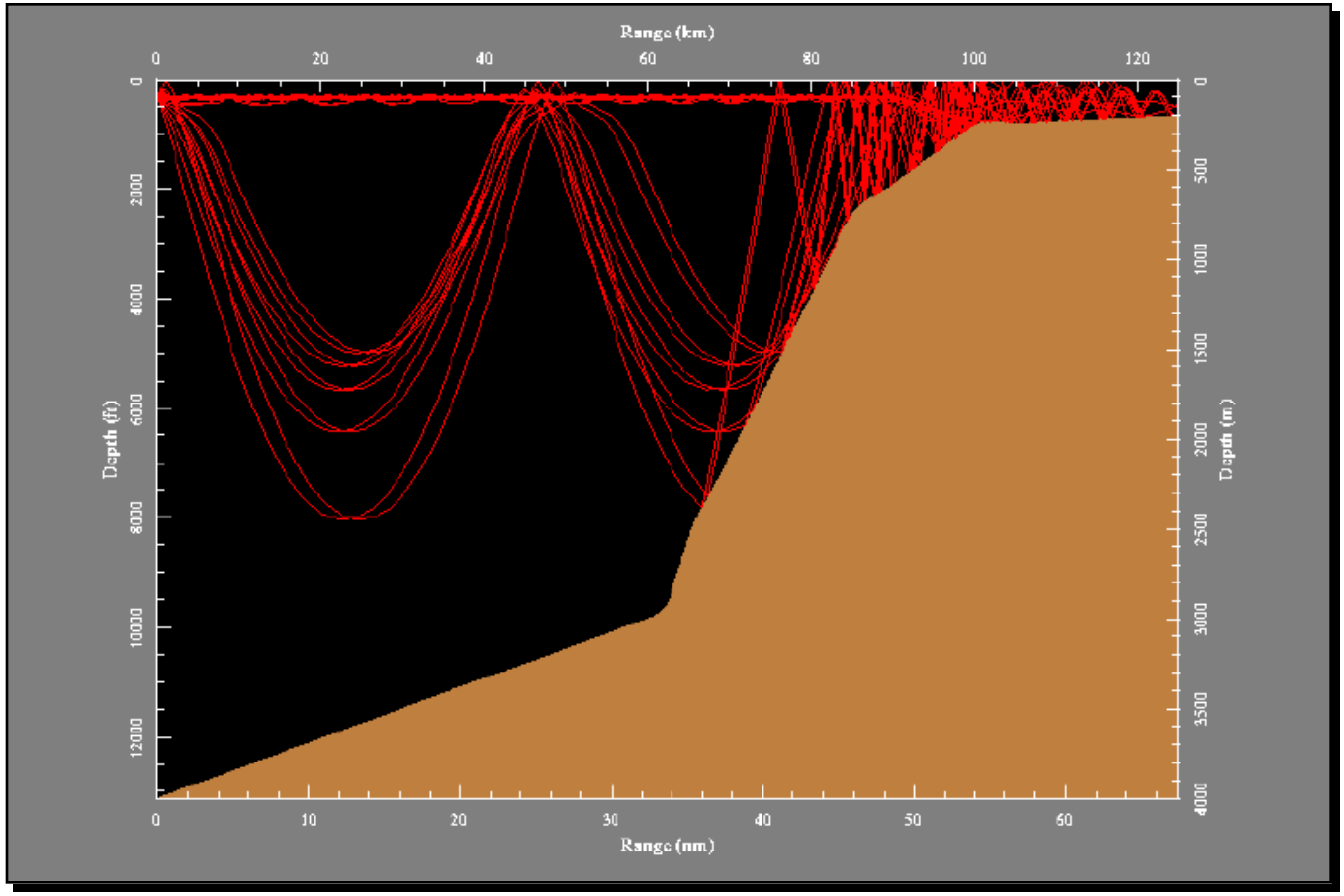
Typical Deep Water Sound Speed Profile



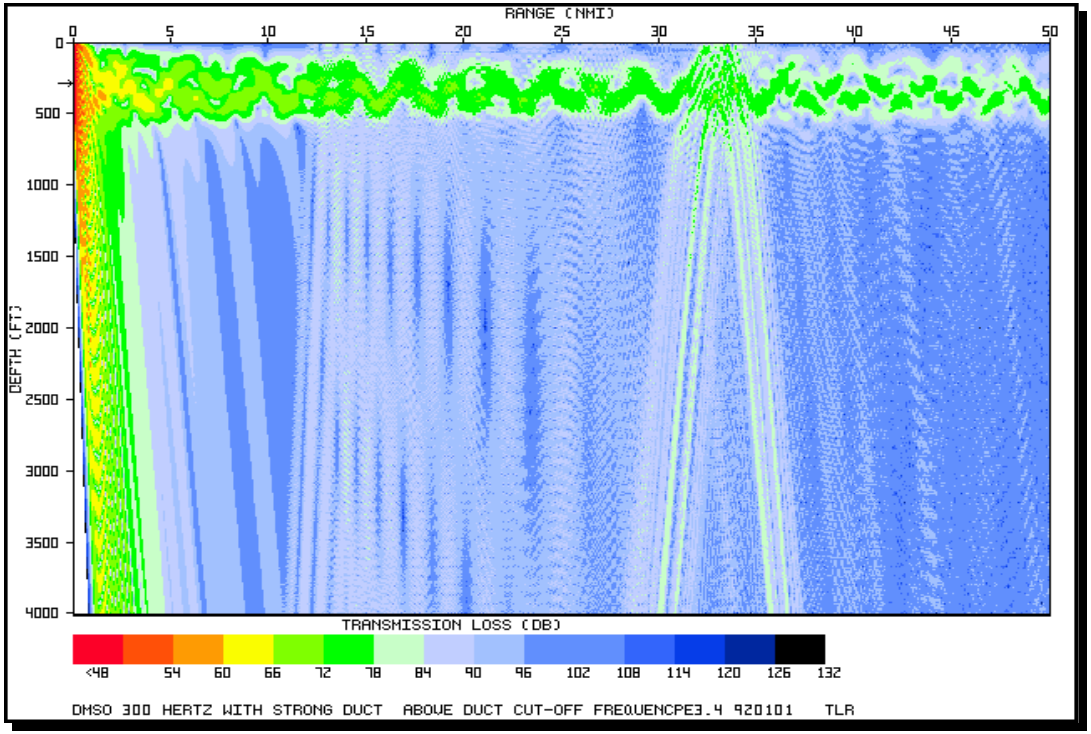
Important Propagation Phenomena

- Multipath
- Ducts
- Shadow Zones
- Convergence Zones
- Bottom Interaction

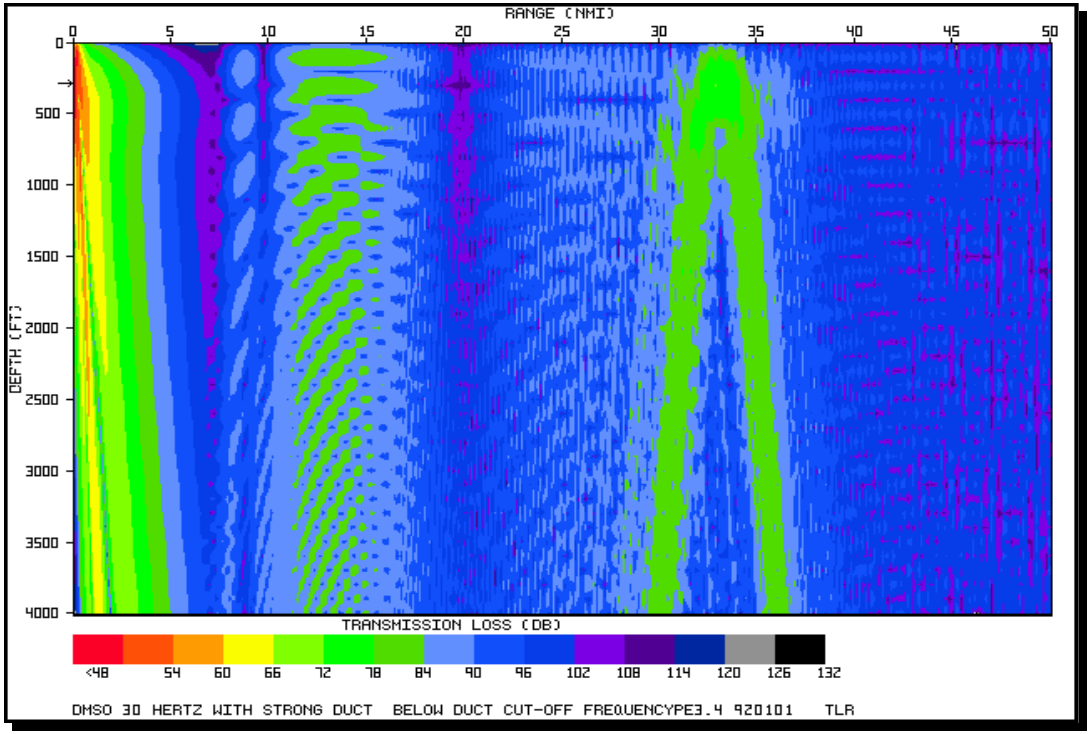
Ducted Upslope Propagation (Ray Diagram)



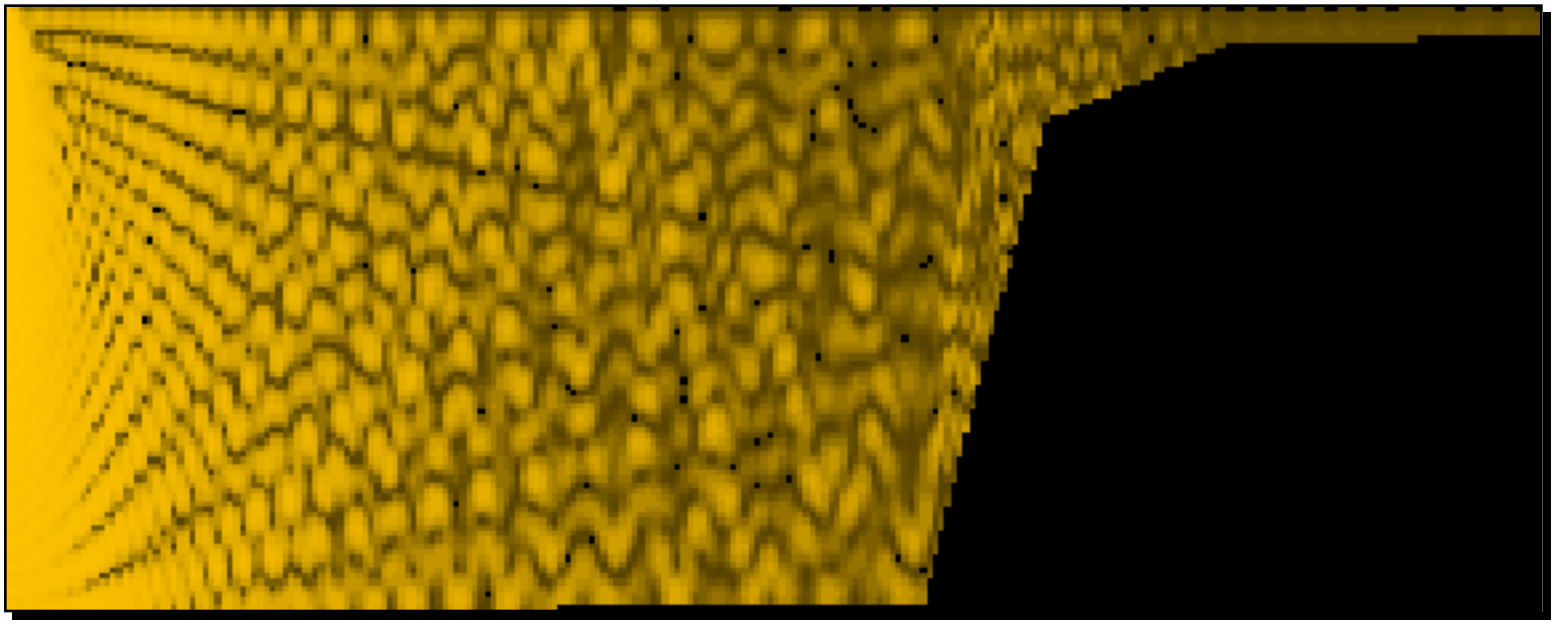
Strong Duct Above Duct Cut-off Frequency (300 Hertz)



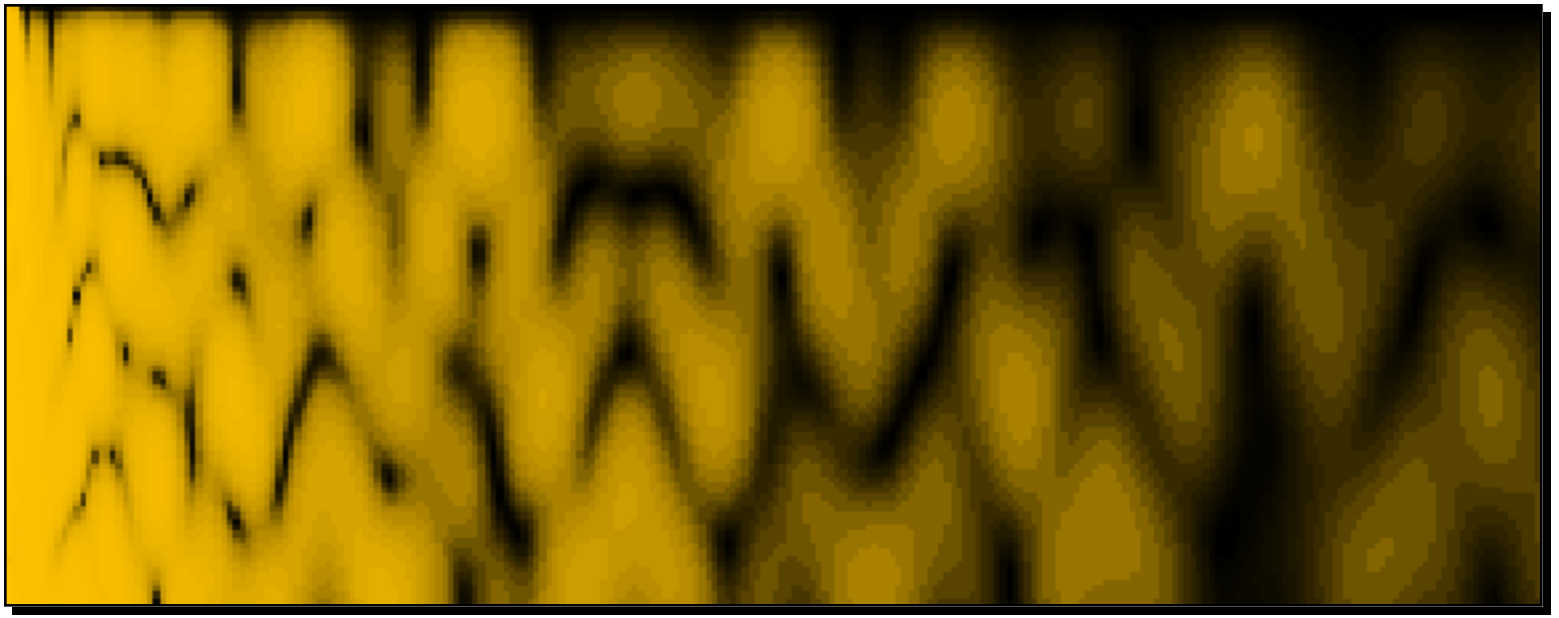
Strong Duct Below Duct Cut-off Frequency (30 Hertz)



Upslope Propagation (High Fidelity Model)



Low Fidelity Model
(No Ducts or Range Dependence)



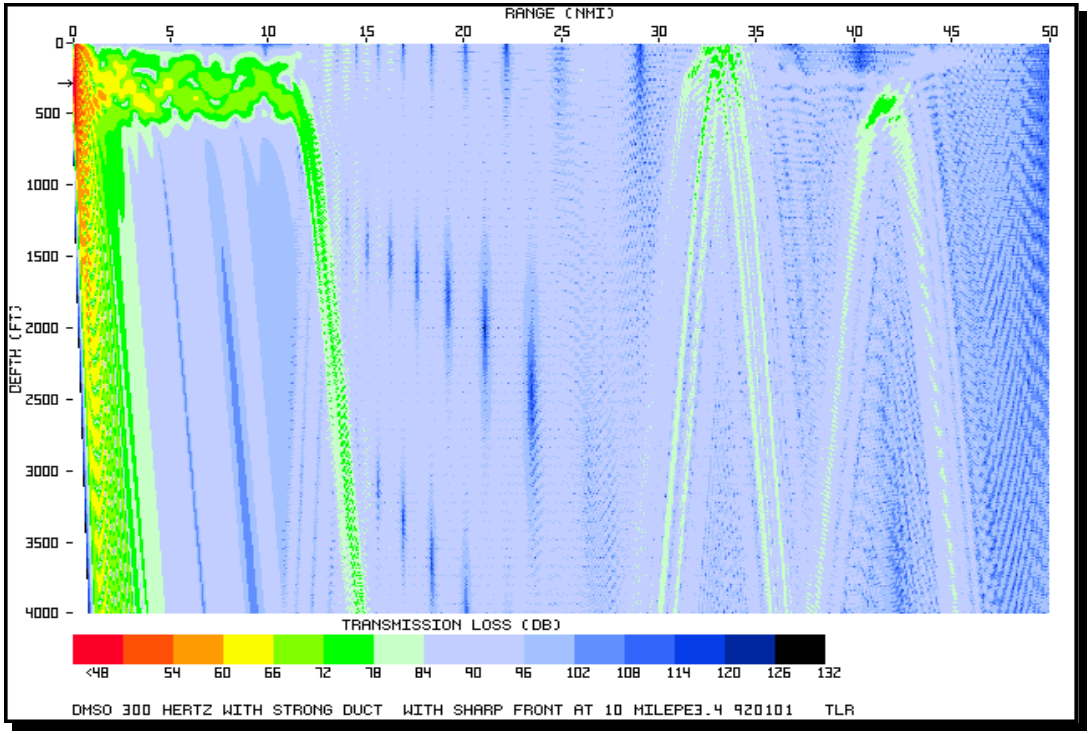
Gaming Strategies

- **Exploit Conditions Where Your Model Gives You an Acoustic Advantage Over Your Adversary's Model - Where You Can Hold Contact While Avoiding Counter-Detection.**
  - Three to Six Decibels Can Double Your Detection Range

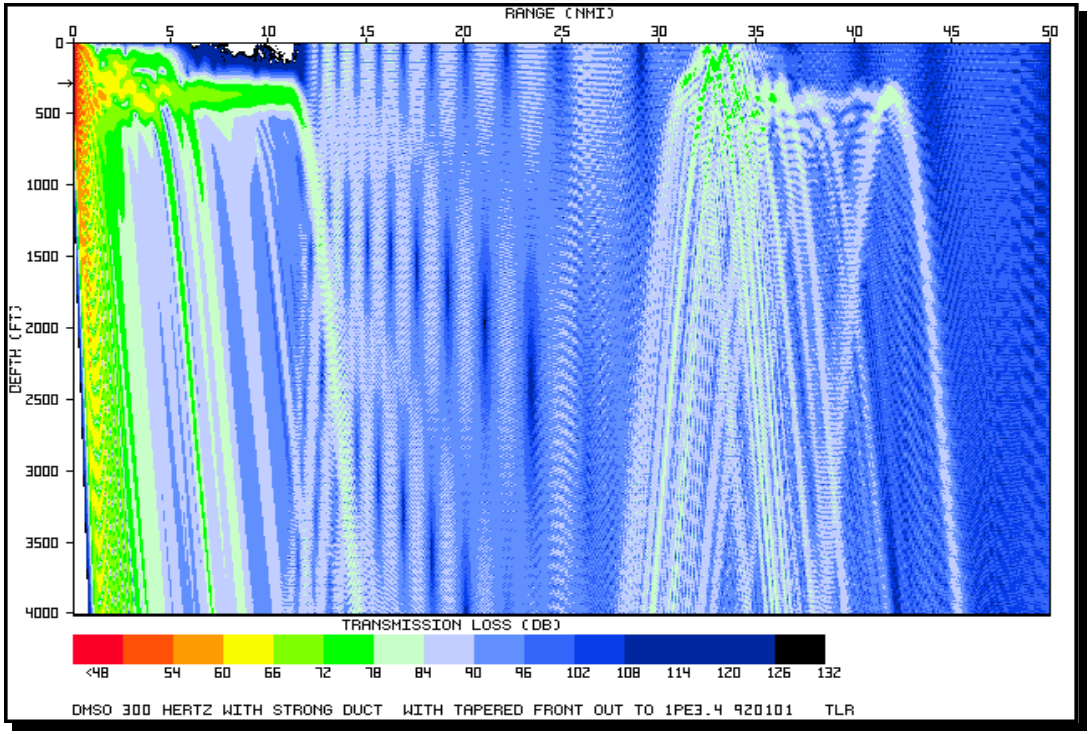
Exploiting Model Fidelity Differences

- **If Your Adversary's Model Supports Shadow Zones but Your Model Does Not**
  - Hide in Shadow Zone: You Can Detect but Your Adversary Cannot Counter-Detect
- **If Your Adversary's Model Supports Ducts but Your Model Does Not**
  - Stay Below the Duct: You Can at Least Cancel Your Adversary's Advantage

Duct with Sharp Front at 300 Hertz



Duct with Gradual Transition to a Front at 300 Hertz



Current USW Interoperability Status

- **Surface USW**
  - Battle Force Tactical Trainer (BFTT)
    - AN/SQQ-89(V) T( ) OBT
- **Air USW**
  - Many Different Devices and No Interoperability
  - Planned Upgrade and Commonality Through the Generic Acoustic Stimulation System (GASS)
- **Submarine USW**
  - Limited Interoperability

Battle Force Tactical Trainer (BFTT)

- **Multiple Ships/Ship Types**
- **Onboard Acoustics Provided by AN/SQQ-89(V) (T) OBT**
  - Table Driven Environmental Models
    - One Kiloyard Range Resolution
    - Seven Depth Combinations
  - Range Independent
- **Tactical Equipment Stimulated**

Generic Acoustic Stimulation System (GASS)

- **Run-Time Model**
  - "Continuous" Range and Depth Coverage
- **Data Base Resolution**
  - One Half Degree
  - Three Months
  - Manual Overlays for Finer Resolution

GASS (Continued)

- **Range Dependent**
  - Sound Speed Profiles (SSP)
  - Bottom Topography
  - Bottom Type
- **Data Interpolation Issues**
  - False Layers
  - Range Cell Edge Issues